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(71) Applicant(s)
Lutz-Pumpen GmbH & Co. KG

(Incorporated in the Federal Republic of Germany)

Erlenstrasse 5-7, 97877 Wertheim,
Federal Republic of Germany

(72) Inventor(s)
Thomas Sigel
Klaus Saemann
Matthias Röhl

(74) Agent and/or Address for Service
Dr Walther Wolff & Co
6 Buckingham Gate, LONDON, SW1E 6JP,
United Kingdom

## (54) Surface cooled electric motor

(57) An electrical motor comprises an encapsulated motor housing (11) which is closed at both ends by bearing plates (13, 14) and in use is connected to earth potential. Arranged in the housing are a stator (18) and a rotor (20) with a rotor shaft (22), which is rotatably mounted in the bearing plates and extends out of the housing at both ends. A fan wheel (32), which is covered by a cap (34), is arranged on the shaft (22) outside the housing at an end remote from a drive output end. The cap encloses the adjacent bearing plate (4) and forms cooling air outflow paths for guidance of cooling air from the fan wheel to and over those regions of the housing (11) which surround the stator and the rotor. A mounting plate (15), through which the shaft (22) extends and which receives electrical connecting and switching elements (46, 47) arranged peripherally to the shaft, is arranged within the housing remote from the drive output side. Electrical supply lines (50) are led from these connecting and switching elements out of the motor housing by way of pressure-tight feedthroughs (51).

Fig.3

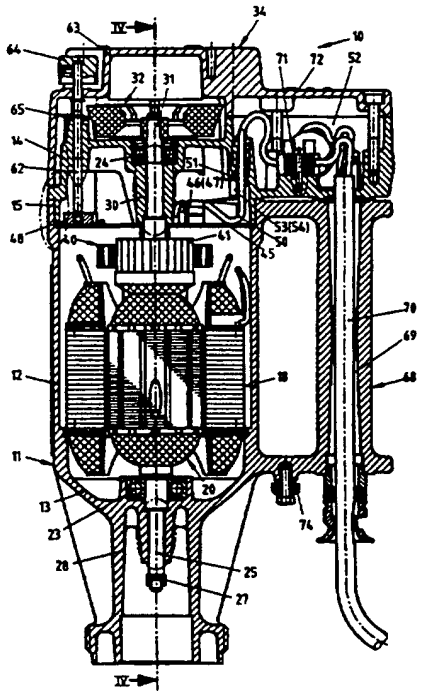

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Fig. 1

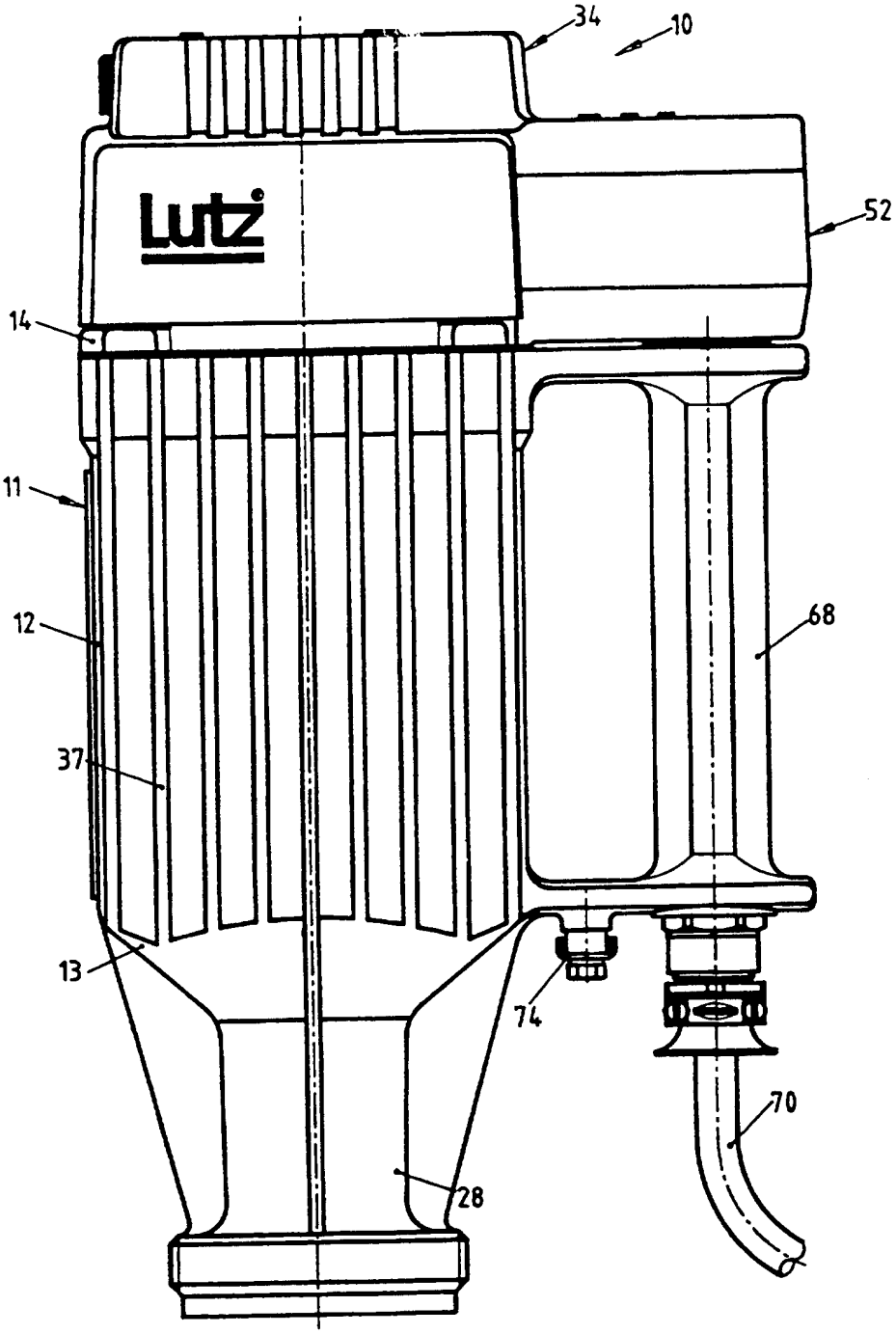


Fig.2

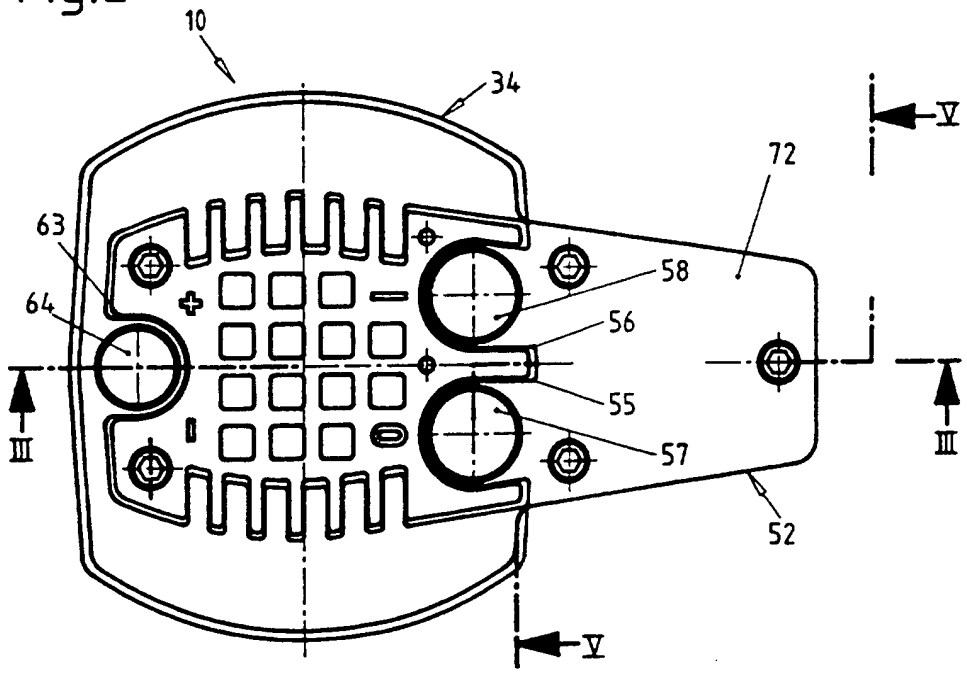



Fig.5

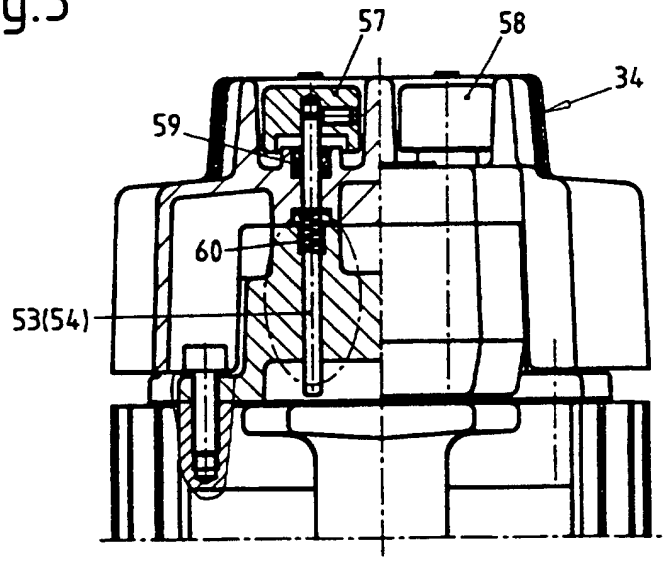


Fig.3

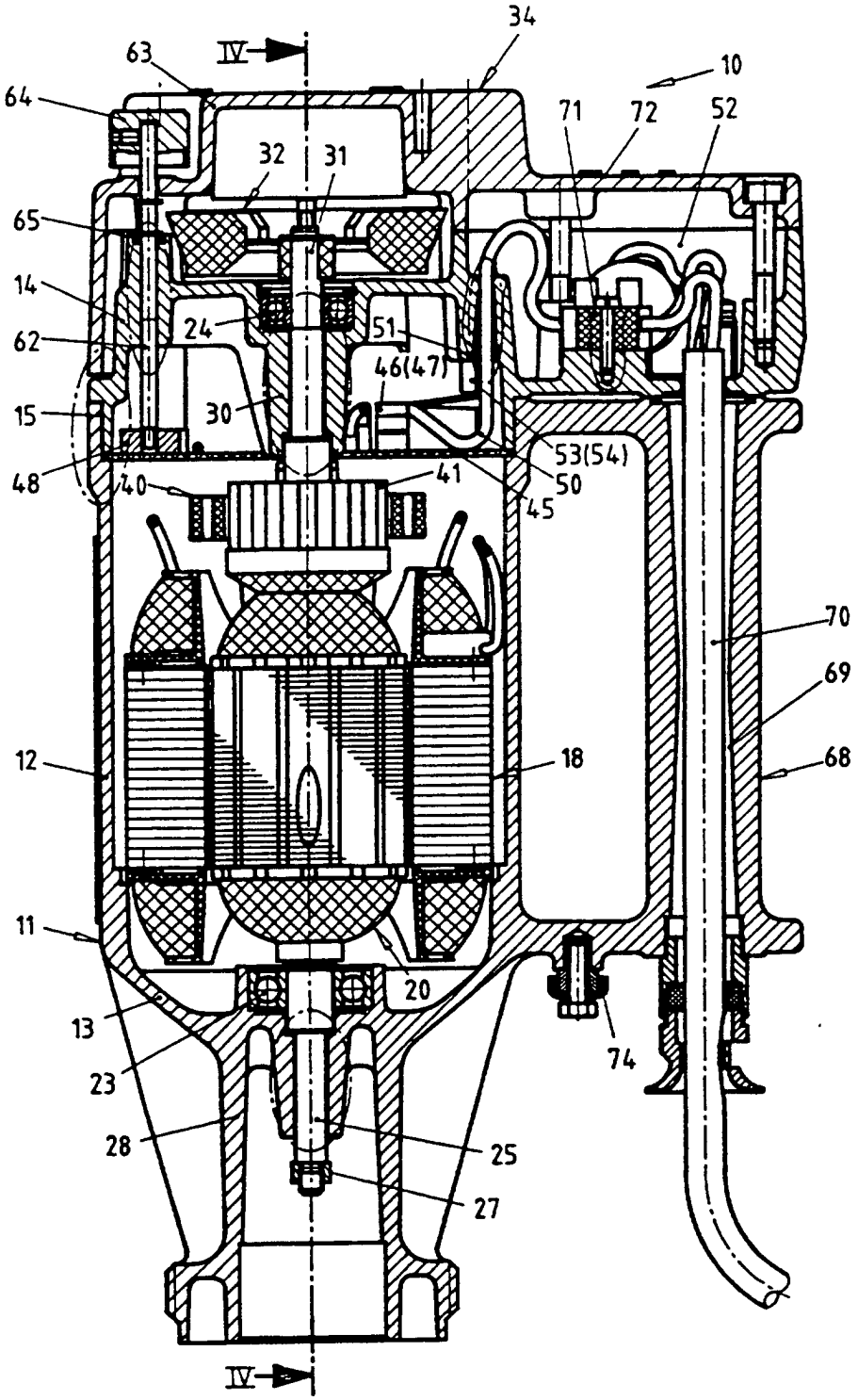
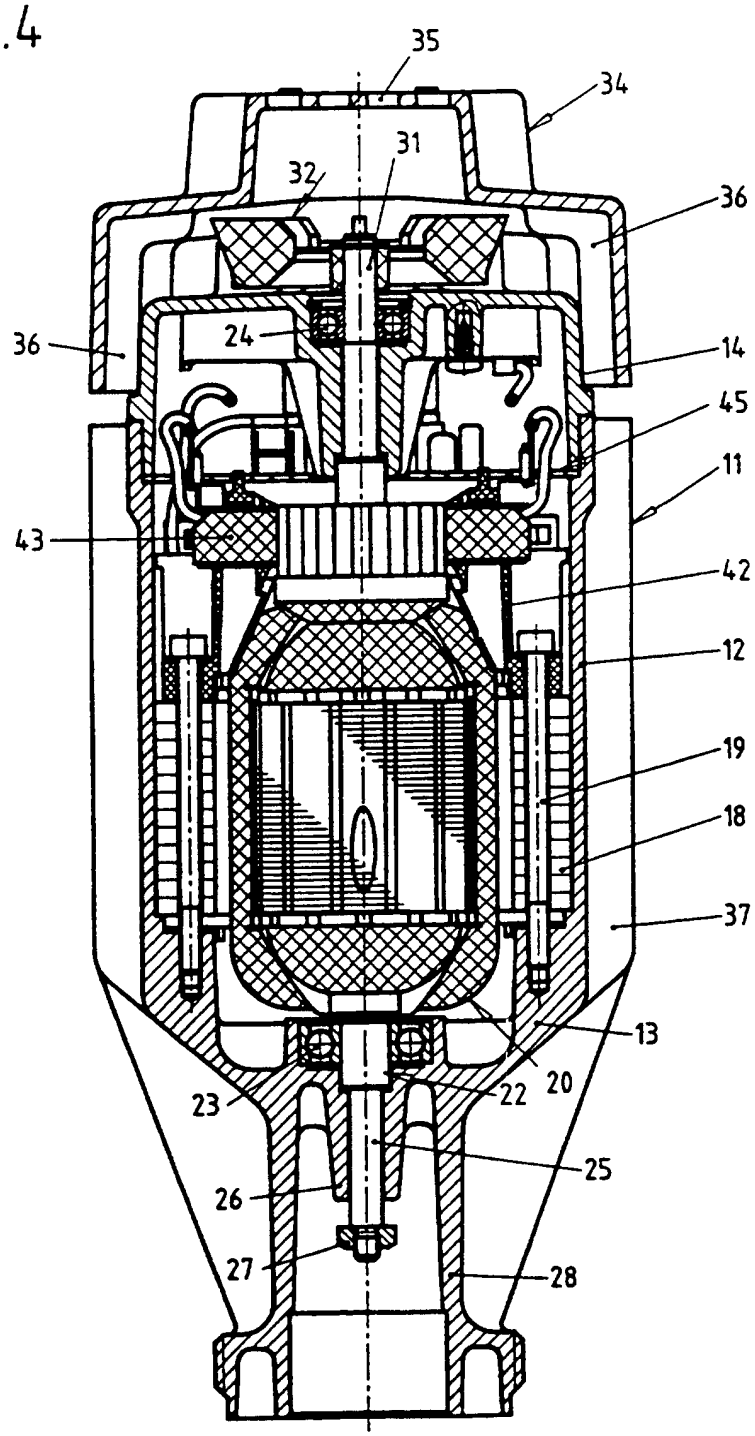


Fig.4



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# ELECTRICAL MOTOR

The present invention relates to an electrical motor, especially a drive motor for a barrel or container pump.

Barrel and container pumps are frequently used for conveying explosive substances. It must therefore be made certain that no static charges arise during operation and no sparks emanate from the drive motor. In order to meet these requirements, electrical motors with fully encapsulated housings and double protection insulation and encapsulated metal housings connectible to earth potential have been used as drive motors for barrel and container pumps.

A drive motor constructed as an explosion-proof electrical motor and for a barrel or container pump is described in DE-OS 30 12 715. This motor comprises a metallic motor housing encapsulated to be pressure-tight and is provided with a double protection insulation in that all parts which can be touched or lead to the outside are insulated additionally to the usual insulation. The additional insulation comprises an inner lining of the motor housing with an insulating synthetic material casing, a corresponding lining of the motor shaft, and screening of shaft through bores. In the same manner as the motor housing, terminal and switch housings, which are connected therewith and similarly encapsulated to be pressure-tight, are lined at the inside with insulating synthetic material casings.

In the case of the prior known electrical motor, it is ensured that, provided the additional insulation in the form of synthetic material casings is not damaged, parts that could be touched by an operative are not at voltage. Less satisfactory, however, is the considerable

constructional complication and problems of outward heat removal caused by the internal lining of the housing by synthetic material casings.

A motor of this kind, in which an encapsulated motor housing is surrounded by an envelope of electrically non-conductive material and cooling air slots extend through between this envelope and a middle housing part, is also known from DE-PS 38 15 427. The envelope provides an effective screening of all metallic parts of the motor where voltage could be present in the case of possible damage of the insulation and thus gives reliable protection against touching. Moreover, effective heat removal is ensured by the cooling air slots extending between the outer envelope and the middle housing part.

Although a heat removal meeting requirements is provided with this motor, constructional complication is still high.

A motor, which is used in great numbers as a drive motor for barrel and container pumps particularly in the United States, with an encapsulated metal housing connectible to earth potential, is described in a prospectus of the applicants. This motor, which comprises a cable and switch box projecting laterally from the motor housing, is heavy and not easy to manipulate, as well as being relatively costly to manufacture.

There is therefore a need for an electrical motor which may be suitable for the drive of barrel or container pumps and which may be relatively simple and economic to manufacture.

According to the present invention there is provided an electrical motor which comprises an encapsulated motor housing, which is closed off at both ends by bearing plates and on use as intended can be applied to earth potential and in which a stator is received to be in fixed position

and a rotor with a rotor shaft, which is mounted in the region of the bearing plates to be rotatable as well as led out of the motor housing at both ends, is received, in which a fan wheel is arranged on the motor shaft to be secure against relative rotation and outside the motor housing on the side remote from the drive output and is covered by a cover cap which has at least one cooling air induction opening, surrounds the adjoining bearing plate whilst forming cooling air outflow paths open towards the drive output side and guides cooling air conveyed by the fan wheel at the outward side to regions of the motor housing surrounding the stator and the rotor, and in which a mounting plate is arranged within the motor housing on that side of the rotor which is remote from the drive output side, through which mounting plate the rotor shaft extends and which mounting plate receives electrical connecting and switching elements arranged peripherally to the rotor shaft, and in which electrical supply lines are led to the outside out of the motor housing by way of line feed-throughs constructed to be pressure-tight.

A motor so constructed is relatively simple in construction, can be manufactured at favourable cost and is easy to manipulate. Expediently, a middle part of the motor housing is provided with cooling ribs which extend in the longitudinal direction of and project radially from the housing and are arranged at a spacing from each other in circumferential direction. These cooling ribs form cooling air guide channels in a particular direction and contribute to an appreciable increase in the external surface area brushed by the cooling air and thus to an effective heat removal.

The arrangement of the electrical connecting and switching elements peripherally to the motor shaft on the mounting plate within the motor

housing has proved to be advantageous. This particularly applies when the mounting plate is arranged between a middle part of the motor housing and the bearing plate remote from the drive side.

Another development provides that the pressure-tight feedthroughs extend through the bearing plate remote from the drive side. These feedthroughs to advantage comprises recesses, which enlarge towards the interior space of the housing and are filled with a casting mass enclosing the electrical supply lines, so as to provide a high degree of security in relation to detonation within the housing. Detonations of that kind can never be completely excluded during the conveying of explosive media, because the passage bores for the rotor shaft cannot with absolute certainty prevent gradual ingress of such substances into the motor housing.

Another development provides that a wiring cavity is formed at the bearing plate remote from the drive output side of the motor and a tension-relieved electrical cable is introduced into this cavity. Expediently, the cavity is situated above a handle which is formed at a middle part of the motor housing to project laterally therefrom and the cable is introduced through the handle into the wiring cavity. At the upper side, the cavity can be closed off by the cover cap engaging over the fan wheel.

In another development, the switching elements arranged on the mounting plate each comprise a respective on-off switch constructed as pushbutton switch and respectively actuable by way of a pushbutton pin which extends through a longitudinal guide of the bearing plate remote from the drive output side of the motor and is connected with a pushbutton knob received in a recess in the cover cap.

Alternatively thereto, a rotational speed setter can be arranged on the mounting plate and is actuable by means of a shaft which is connected with a rotary knob and extends through a bearing bore in the bearing plate remote from the drive output side of the motor.

Since the actuating means for the pushbutton switches and for the rotational speed setter necessarily have to extend to the outside, these can be provided with sealing means and also means for resetting to an inactive setting. It has also proved to be advantageous if the pins longitudinally movable in longitudinal guides and the shaft rotationally movable in a bearing bore have substantial longitudinal dimensions in the interest of longest possible creepage paths.

Preferably, the motor is equipped with an undervoltage trigger which switches off the motor in the case of current failure and which can also be arranged on the mounting plate. Such a trigger ensures that the motor does not start up unexpectedly on sudden current return after a current failure, but rather requires an intentional switching-on after each interruption caused by current failure.

An embodiment of the invention will now be more particularly described by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a side view of a motor embodying the invention;

Fig. 2 is a plan view of the motor;

Fig. 3 is a longitudinal section of the motor along the line III-III in Fig. 2;

Fig. 4 is a longitudinal section of the motor, turned through 90° relative to Fig. 3, along the line IV-IV in Fig. 3; and

Fig. 5 is a partial section, along the line V-V in Fig. 2, of a cover cap and a bearing region of a pushbutton pin in the motor.

Referring now to the drawings there is shown an electrical motor 10, which is constructed as a universal motor, for the drive of a barrel pump. The motor comprises a housing 11 made of, for example, cast aluminium and consisting of a tubular middle housing part 12 and two bearing plates 13 and 14 closing the middle part 12 at both end faces thereof. The bearing plate 13 at the drive output side is formed integrally with the housing part 12 and the other bearing plate 14 is inserted in known manner into an end face machined recess 15 of the housing part 12 and screw-connected thereto. A stator 18 is received in the middle part 12 and fastened by means of threaded bolts 19 extending almost to the bearing plate 13 at the drive output side.

An armature 20 concentrically enclosed by the stator 18 is rotatably mounted by means of a shaft 22, which extends out of the housing 11 at both ends and is rotatably mounted in bearings 23 and 24 respectively located in the bearing plates 13 and 14. The shaft 22 has, at the drive output side, a shaft stub 25 extending through a hub 26 of the bearing plate 13 which is integrally formed on the middle housing part 12. The free end of the shaft stub 25 at the drive output side is equipped with a quick-action coupling device 27 for coupling to a drive shaft of a barrel pump (not shown). A shroud 28, which surrounds the shaft stub 25 with the coupling device 27 and projects beyond these, extends from the bearing plate 13.

On the side remote from the shaft stub 25, the shaft 22 extends through a hub 30 of the bearing plate 14 terminating the housing part 12,

and a fan wheel 32 for conveying of cooling air is mounted on a shaft stub 31 which projects beyond the bearing plate 14. The fan wheel 32 is covered by a cap 34 at the side thereof remote from the bearing plate 14, which cap has a plurality of air induction openings 35 and engages axially over the bearing plate 14. Axially directed outflow paths 36 for the cooling air conveyed by the fan wheel 32 are formed between the bearing plate 14 and the cap 34 on at least two mutually opposite sides. In the region of these cooling air outflow paths 36, which each extend over a circumferential region of about 120°, the housing middle part 12 is provided with radially projecting and circumferentially spaced apart cooling ribs 37 which extend in the longitudinal direction of the housing as far as the bearing plate 14 integrally formed on the part 12. The stator 18 lies directly against the housing middle part 12 in this circumferential region, as shown in Fig. 4. Thus, a good removal of heat is ensured.

A current-commutating device 40 with a collector 41, which is coaxial with the armature 20 and mounted on the shaft 22 to be secure against rotation relative thereto, is arranged on the side of the armature 20 facing the fan wheel 32. The device 40 comprises brush holders 42, which are fastened at the stator 18 at the inward side of the housing, with carbon brushes 43 bearing against the collector 41.

A mounting plate 15, through which the shaft 22 extends, is located in the housing 11 between the middle part 12 and the bearing plate 14. The bearing plate 14 comprises the hub 30, which projects towards the current-commutating device 40 and reaches into the region of the mounting plate 45. Switching and connecting elements of the motor 10 are arranged on the mounting plate 45 peripherally of the shaft 22 and the

hub 30 surrounding this. The switching elements comprise on-off switches 46 and 47, each constructed as pushbutton switch, a rotational speed setter 48, and an undervoltage trigger (not shown) which, in the case of current failure, provides switching-off of the motor 10 and prevents automatic restarting on restoration of current.

The switches 46 and 47 are each connected with a respective plug contact and the latter are connected with electrical supply lines 50, which are led out of the motor housing 11 through pressure-tight line feedthroughs 51 in the bearing plate 14. The feedthroughs 51 are provided by openings which penetrate the bearing plate in axial direction, enlarge towards the interior of the housing and are filled with a casting mass embedding the electrical supply lines. These lines open into a wiring chamber 52, which is described more closely below.

The actuation of the switches 46 and 47 is effected by means of respective elongate pins 53 and 54, which are guided in longitudinal guides in the bearing plate 14 and the cap 34 and are connected with pushbutton knobs 57 and 58 received in recesses 55 and 56 at the upper side of the cap 34. These pins are each sealed off towards the interior of the housing by means of a ring seal 59 arranged in the region of the cap and are acted on by a respective biassed spring 60 against their direction of actuation.

The actuation of the rotational speed setter 48 is by means of a rotatable shaft 62, which is received in a longitudinal guide bore penetrating the bearing plate 14 and is connected at one end with a rotary knob 64 arranged in a recess 63 at the upper side of the cap 34. The shaft 62 is sealed by means of an O-ring seal 65 in the region of the guide bore.

A laterally projecting holding handle 68, through which a cable feedthrough 69 for a tension-relieved supply cable 70 extends, is formed on the housing middle part 12 in the region between the portions provided with longitudinally extending cooling ribs 37. The bearing plate 14 comprises, in the region of the handle, an integral extension defining a wiring chamber 52, into which the cable 70 is introduced and in which connecting terminals 71 are situated. The electrical lines of the supply cable 70 and the electrical supply lines 50 led out of the interior of the motor are connected together by these terminals. At the upper side, the cavity 52 is closed by a cover 72 projecting laterally from the cap 34 and this cover is firmly connected by screw connections with parts of the bearing plate 14.

The motor 10 illustrated as an embodiment is an externally ventilated universal motor, the metallic motor housing 11 of which is in use intended to be connected to earth potential. For this purpose, a connecting terminal 74 for the application to earth potential is disposed at the level of the cable introduction into the handle 68 and mounted thereto at the underside. In use, the shaft 22 is connected by way of the quick-action coupling device 27 with the drive shaft of a barrel pump. In operation, the fan wheel 32, which is remote from the drive output side of the motor 10, inducts cooling air through the cooling air entry openings 35 in the cap 34, which cooling air is guided along the housing 11 in the region of the ribs 37 and through the axially directed outflow paths 36 evident in, in particular, Fig. 4. By virtue of the cooling ribs 37, which are arranged at a spacing in circumferential direction and extend in the longitudinal direction of the housing, cooling air channels extend along the housing middle part 12 at the

outside and ensure a good coupling air guidance and, due to the increase in surface are provided by the ribs, an effective heat removal.

## CLAIMS

1. An electrical motor comprising a housing closed at two opposite ends thereof by end members, a stator fixedly mounted in the housing, a rotor with a rotor shaft mounted in the region of the end members and extending at both ends out of the housing, a fan wheel mounted on the shaft to be secure against rotation relative thereto and disposed outside the housing at a side thereof opposite a drive output side, a cover covering the fan wheel and having at least one cooling air induction opening, the cover surrounding an adjacent one of the end members and forming cooling air paths for guidance of cooling air from the fan wheel towards a region of the housing surrounding the stator and the rotor, and a mounting member arranged in the housing at a side of the rotor remote from said drive output side and provided with peripherally disposed electrical connecting and switching means, the shaft extending through the mounting member and passage means being provided for electrical conductors extending out of the housing.

2. A motor as claimed in claim 1, wherein the housing is encapsulated and the electrical components of the motor are so arranged that an earth connection for the components can be produced by way of the housing.

3. A motor as claimed in claim 1 or claim 2, the passage means being arranged to be pressure-tight.

4. A motor as claimed in any one of the preceding claims, wherein the housing is provided at the outer circumference of a body portion thereof with spaced apart cooling ribs extending in a longitudinal direction of the housing.

5. A motor as claimed in any one of the preceding claims, wherein the mounting member is disposed between a body portion of the housing and said one of the end members.

6. A motor as claimed in any one of the preceding claims, the passage means being provided in said one of the end members.

7. A motor as claimed in any one of the preceding claims, the passage means being formed by openings which enlarge towards the interior of the housing and are filled with cast material enclosing the conductors.

8. A motor as claimed in any one of the preceding claims, wherein said one end member is provided with a wiring chamber for receiving an electrical cable electrically connectible to the conductors.

9. A motor as claimed in claim 8, wherein the wiring chamber is closed by the cover.

10. A motor as claimed in claim 8 or claim 9 wherein the housing is provided on a body portion thereof with a laterally projecting handle having a cable feed passage communicating with the wiring chamber.

11. A motor as claimed in any one of the preceding claims, the connecting and switching means comprising a plurality of switches each actuable by way of a respective pin extending through said one of the end members and an associated pushbutton mounted in the cover.

12. A motor as claimed in any one of the preceding claims, comprising a rotational speed setting device mounted on the mounting member and actuable by means of a shaft extending through said one of the end members and an associated rotary knob.

13. A motor as claimed in claim 12 when appended to claim 11, wherein the shaft and each of the pins has an extended length to provide an extended creepage path.

14. A motor as claimed in any one of the preceding claims, comprising an undervoltage trigger arranged to switch off the motor in response to failure of current supply thereto.

15. An electrical motor substantially as hereinbefore described with reference to the accompanying drawings.

The Patent Office

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|---|---|---|---|
| **Application No:** | GB 9613658.5 | **Examiner:** | John Cockitt |
| **Claims searched:** | 1-15 | **Date of search:** | 30 August 1996 |

## Patents Act 1977
## Search Report under Section 17

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H2A [AKB3, AKB2, AKK1]

Int Cl (Ed.6): H02K [05/18, 05/20, 09/06, 09/22, 09/28, 11/00]

Other:

**Documents considered to be relevant:**

| Category | Identity of document and relevant passage | | Relevant to claims |
|---|---|---|---|
| A | EP0074514A1 | ISARTALER | |
| A | WO88/09077A1 | FIRMA | |
| A | US4908538A | GEBERTH | |

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